

# Appendix C

## Detailed Economic Evaluation of Centralized Project

Thorough economic analysis of a centralized digester project to process all of the dairy manure of the Enumclaw Plateau. Project includes digester technology for conversion of waste to biogas, organic fertilizer and environmental incentives, as well as membrane technology to produce re-use or discharge quality water and high density liquid fertilizer.

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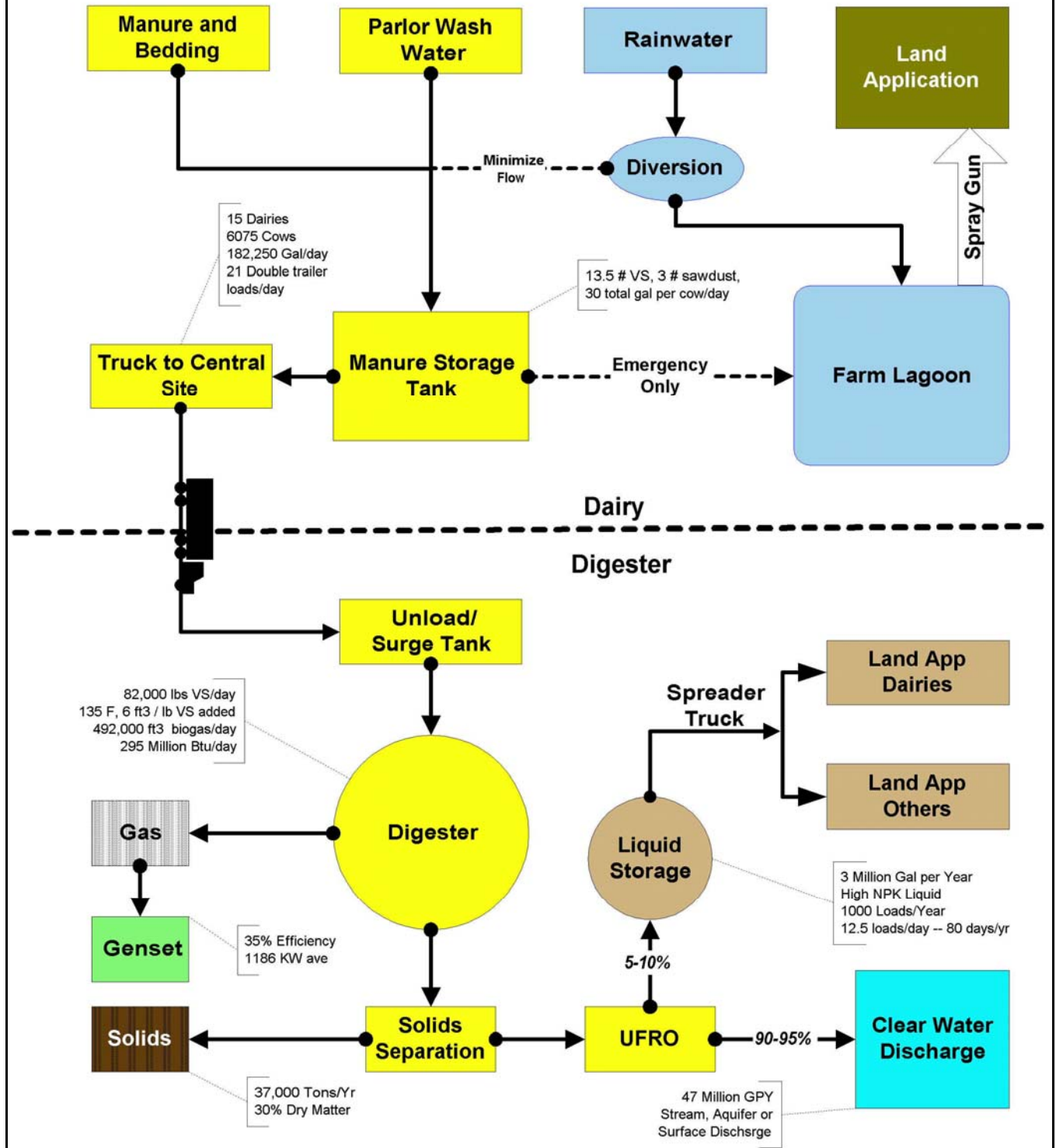


## **Exhibit C -1 – Flow Diagram of Centralized Waste Conversion Project**



# Flow Chart -- Dairy Waste Conversion Project

With UFRO



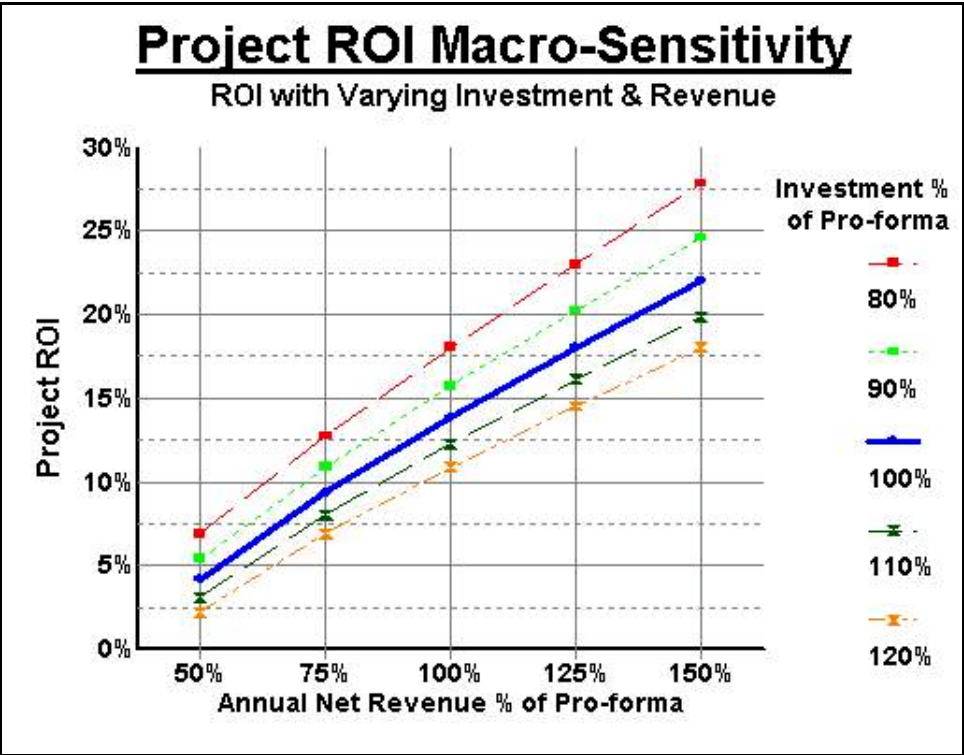
## **Exhibit C-2 – Summary of Project Economic Analysis**







Exhibit C-3 – Project Sensitivity to Capital and Income Deviations



## **Exhibit C-4 – Adjustment Worksheet for Project Customization**



## Adjustments to Income, Expense and Capital Costs

Dairy --- Thermophilic 13.84%

		Cost/Value			
		Each	Amount		
<b>Capital Cost</b>					
Transport Trailers	15	@	\$15,000	\$225,000	
Transport Tractors	5	@	\$25,000	\$125,000	
Fertilizer Plant Fixed	1	@	\$500,000	\$500,000	
Fertilizer Plant Variable	36,568	@	\$20	\$731,352	
Secondary Water Treatement	1		\$500,000	\$500,000	
Site and Preparation	1	@	\$500,000	\$500,000	
PSE Interconnect & Lines	1	@	\$450,000	\$450,000	
Spreader Truck	2	@	\$25,000	\$50,000	
			<b>Total</b>	\$3,081,352	
<b>Income</b>					
Processing Fee	6,075	Milkers	@	\$40.00	\$243,000
Organic Residuals Sale	36,568	Tons	@	\$20.00	\$731,352
Renewable Energy PTC	10,385,992	KWHr	@	\$0.018	\$186,948
Carbon Credits	38,576	M Tons	@	\$4.00	\$154,304
Renewable Attributes Premium	10,385,992	KWHr	@	\$0.020	\$207,720
Nutrient Rich Water (75%)	1,681	000 G	@	\$80.00	\$134,483
			<b>Total</b>	\$1,657,807	
<b>Operating Cost</b>					
Residuals Handling (not bagging)	36,568	Tons	@	\$5.00	\$182,838
Facility Operation exc GenSet	1			\$350,000	\$350,000
Transport Cost	251,884	Tons	@	\$0.60	\$151,131
Water Processing Cost	42,586	000 G	@	\$1.50	\$63,879
Liquid Application	2,241	000 G	@	\$15.00	\$33,621
			<b>Total</b>	\$781,469	

## **Exhibit C-5 – Pro-forma Operating and Capital**

## Proforma Investment and Operating Statement

Dairy --- Thermophilic 13.84%

### Income

#### Electricity

Net metered Power	\$0	0%
Demand	\$0	0%
Sale to Utility	\$363,510	18%

#### Power Based Incentive

Production Tax Credit	\$186,948	9%
Renewable Attributes	\$207,720	10%

Carbon Credits	\$154,304	8%
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User Fee	\$243,000	12%
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#### Nutrient Value

Residual Solids	\$731,352	36%
Liquid Fraction	\$134,483	7%

<b>Total Revenues</b>	<b>\$2,021,317</b>	<b>100%</b>
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### Expense

#### Operations

Genset R&M	\$103,860	12%
Digester Operations	\$350,000	40%
Solid Residuals Handling	\$182,838	21%
Water Treatment	\$63,879	7%

#### Transportation

Waste Inbound Hauling	\$184,751	21%
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<b>Total Expenses</b>	<b>\$885,329</b>	<b>100%</b>
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<b>Net Revenues</b>	<b>\$1,135,988</b>	<b>56%</b>
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### Capital

Digester & Equipment	\$1,965,102	26%
GenSet & Interconnect	\$1,470,931	19%
Solids Handling	\$1,231,352	16%
Rolling Stock	\$350,000	5%
Land and Development	\$500,000	7%
Engineering & Conting.	\$1,524,693	20%
Other	\$550,000	7%
<b>Total</b>	<b>\$7,592,078</b>	<b>100%</b>

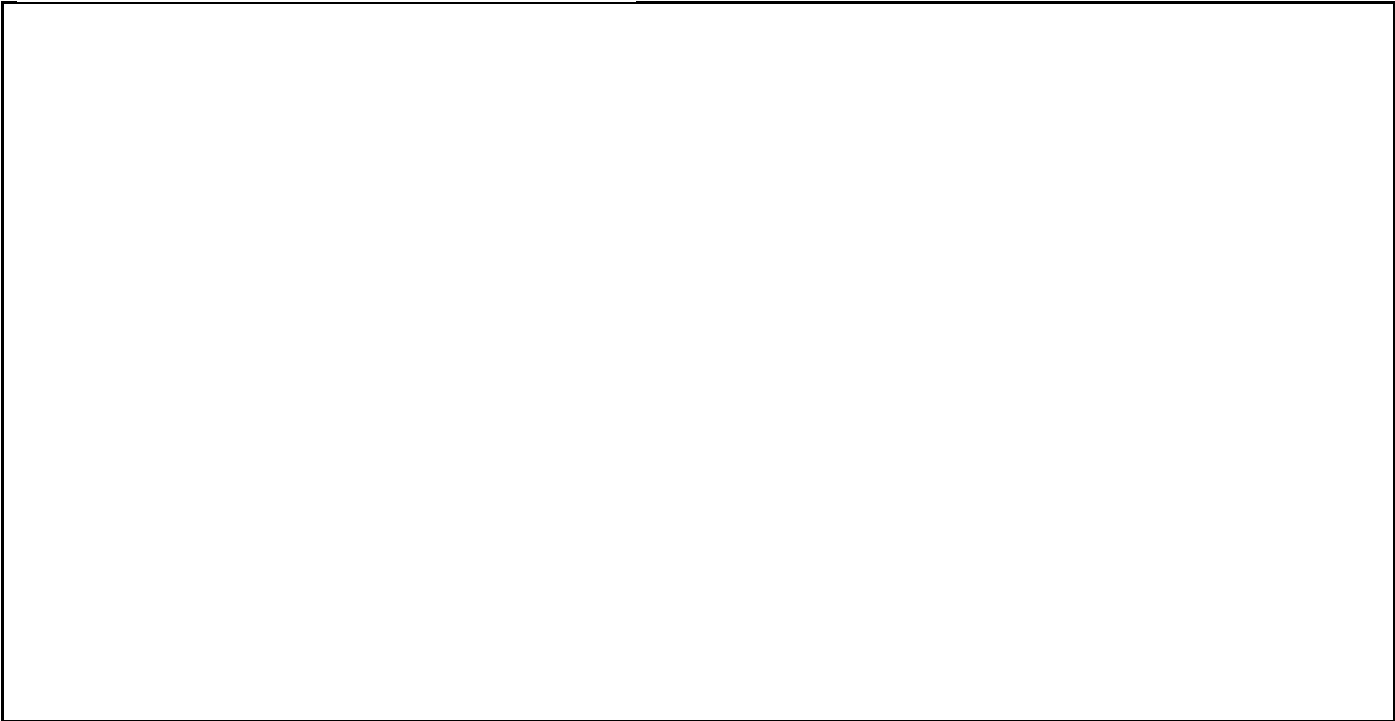
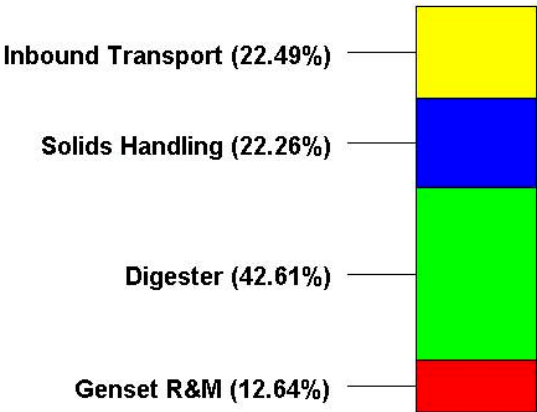
**Exhibit C-6 – Project Income Summary**

<b>Income Items -- Quantity and Price</b>				
	<u>Units</u>		<u>Value</u>	<u>Annual</u>
<b>Electricity Sale</b>	10,386	MWh @	\$35.00	\$363,510
<b>Production Tax Credit</b>	10,386	MWh @	\$18.00	\$186,948
<b>Renewable Attributes</b>	10,386	MWh @	\$20.00	\$207,720
<b>Carbon Credits</b>	38,576	M Ton @	\$4.00	\$154,304
<b>User Fee</b>	6,075	Cows @	\$40.00	\$243,000
<b>Solid Organic Residuals</b>	36,568	Tons @	\$20.00	\$731,352
<b>Liquid Organic Fertilizer</b>	1,681	000 gal @	\$80.00	\$134,483
				<b>\$2,021,317</b>

**Exhibit C-7 – Income, Expense and Capital Component Breakdown**

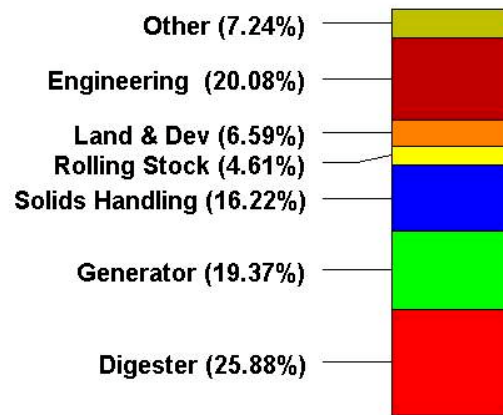
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# Expense Categories





# Capital Items



## Exhibit C-8 – Detailed Sensitivity Analysis of Key Factors

Economic Micro-Sensitivity of Key Project Factors							
Dairy --- Thermophilic 13.84%							
Factor	Base Value		Change By	Effect on			Value for
				Income	Capital	ROI	ROI Target**
							10%
Project Size	6,075	Milkers	1200	\$293,528	\$532,223	2.96%	4588
External Power Price	\$0.035	Per Kwh	\$0.005	\$51,930		0.78%	\$0.012
Renewable Attributes Credit	\$0.020	Per Kwh	\$0.005	\$51,930		0.78%	(\$0.003)
Carbon Credits	\$4.00	Per Ton	\$0.50	\$19,288		0.29%	(\$2.31)
Organics Sale Price	\$20.00	Per Ton Bulk	\$5.00	\$182,838		2.72%	\$13.34
Manure Transport Cost	\$0.60	Per Ton	\$0.10	(\$25,188)		-0.38%	\$1.57
User Fee	40.00	Per Milker	\$5.00	\$30,375		0.46%	\$4.32
Liquid Fertilizer	\$80.00	Per 000 Gal	\$10.00	\$16,810		0.25%	(\$65.18)
Gas Production Factor	6.00	Ft3 / #VS	0.50	\$67,385	\$86,451	0.81%	4.04
GenSet Efficiency	35%	Annual	1%	\$18,695	\$29,640	0.22%	20%
Project Total Capital		One Time	\$500,000		\$500,000	-1.07%	\$2,161,019
Project Net Revenue		One Time	\$50,000	\$50,000		0.75%	(\$243,840)

## Exhibit C-9 – Detailed Sensitivity Analysis with Alternate Scenario

## Economic Micro-Sensitivity of Key Project Factors

Dairy --- Thermophilic 13.84%										
Factor	Base Value	Change By	Effect on			Value for		Effect on		
			Income	Capital	ROI	ROI Target <sup>***</sup>	New Value	Income	Capital	ROI
Project Size	6,075 Milkers	1200	\$293,528	\$532,223	2.96%	4588	6500	\$103,958	\$188,496	1.05%
External Power Price	\$0.035 Per Kwh	\$0.005	\$51,930		0.78%	\$0.012	\$0.035			
Renewable Attributes Credit	\$0.020 Per Kwh	\$0.005	\$51,930		0.78%	(\$0.003)	\$0.010	(\$103,860)		-1.57%
Carbon Credits	\$4.00 Per Ton	\$0.50	\$19,288		0.29%	(\$2.31)	\$4.00			
Organics Sale Price	\$20.00 Per Ton Bulk	\$5.00	\$182,838		2.72%	\$13.34	\$25.00	\$182,838		2.72%
Manure Transport Cost	\$0.60 Per Ton	\$0.10	(\$25,188)		-0.38%	\$1.57	\$0.60			
User Fee	40.00 Per Milker	\$5.00	\$30,375		0.46%	\$4.32	\$25.00	(\$91,125)		-1.38%
Liquid Fertilizer	\$80.00 Per 000 Gal	\$10.00	\$16,810		0.25%	(\$65.18)	\$80.00			
Gas Production Factor	6.00 Ft3 / #VS	0.50	\$67,385	\$86,451	0.81%	4.04	6.50	\$67,385	\$86,451	0.81%
GenSet Efficiency	35% Annual	1%	\$18,695	\$29,640	0.22%	20%	33%	(\$37,390)	(\$59,281)	-0.43%
Project Total Capital	One Time	\$500,000		\$500,000	-1.07%	\$2,161,019				
Project Net Revenue	One Time	\$50,000	\$50,000		0.75%	(\$243,840)				
** All other factors being unchanged						<b>Total Adjustment</b>				
						<b>Original Project</b>		\$121,807	\$215,666	1.21%
						<b>Estimated New Value</b>		\$1,135,988	\$7,592,078	13.84%
								\$1,257,795	\$7,807,744	15.05%

The table above illustrates the ability to evaluate an entirely new scenario within the micro-sensitivity table. After the initial analysis determines the effect of varying each factor independently, the investigator can then combine entirely new values for any or all of the variable factors in the leftmost column. The new value is entered in the column identified "New Value" and the estimated effect of that change on the economics of the project is shown in the columns to the right. The individual effects from the modified factors are then totaled at the bottom and the combined effect of the new scenario is estimated. This is only an estimate because it assumes complete linearity for all of the modified variables. Experience has shown that the estimate will be very close to the value calculated by making the same changes to the main model unless major changes are made to certain technical factors which would change capacities and material volumes.

## Economic Micro-Sensitivity of Key Project Factors

Factor	Base Value		Value of Factor Necessary for Specified ROI Target **					
			6.0%	8.0%	10.0%	Base 13.8%	15.0%	20.0%
Project Size	6,075	Milkers	3639	4080	4588	6,075	6709	9137
External Power Price	\$0.035	Per Kwh	(\$0.010)	\$0.000	\$0.012	\$0.035	\$0.045	\$0.077
Renewable Attributes Credit	\$0.020	Per Kwh	(\$0.025)	(\$0.015)	(\$0.003)	\$0.020	\$0.030	\$0.062
Carbon Credits	\$4.00	Per Ton	(\$8.22)	(\$5.35)	(\$2.31)	\$4.00	\$6.04	\$15.70
Organics Sale Price	\$20.00	Per Ton Bulk	\$7.07	\$10.14	\$13.34	\$20.00	\$22.16	\$32.35
Manure Transport Cost	\$0.60	Per Ton	\$2.57	\$2.03	\$1.57	\$0.60	\$0.29	(\$1.02)
User Fee	40.00	Per Milker	(\$37.38)	(\$17.75)	\$4.32	40.00	\$53.38	\$111.79
Liquid Fertilizer	\$80.00	Per 000 Gal	(\$199.23)	(\$134.95)	(\$65.18)	\$80.00	\$126.64	\$337.84
Gas Production Factor	6.00	Ft3 / #VS	2.08	2.91	4.04	6.00	6.74	10.31
GenSet Efficiency	35%	Annual	6%	12%	20%	35%	42%	69%
Project Total Capital Deviation	\$0.00	One Time	\$5,877,447	\$3,727,033	\$2,161,019	\$0.00	(\$434,808)	(\$2,026,841)
Project Net Revenue Deviation	\$0.00	One Time	(\$470,389)	(\$360,911)	(\$243,840)	\$0.00	\$82,150	\$443,963

\*\* All other factors remaining unchanged at their base value.

### Critical Factor Analysis

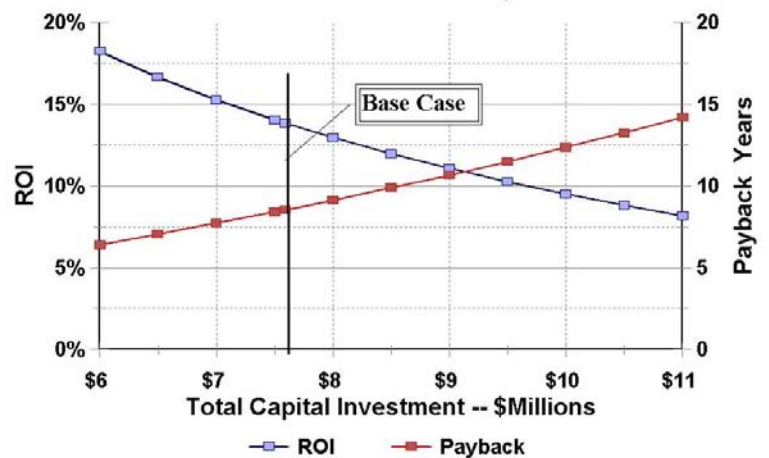
Factor -- Total Capital Investment

Description -- Total investment in the project.

Value	ROI	Payback	Notes
\$6.00	18.3%	6.41 Yrs	Base
\$6.50	16.7%	7.06 Yrs	
\$7.00	15.3%	7.73 Yrs	
\$7.50	14.1%	8.43 Yrs	
\$7.59	13.8%	8.56 Yrs	
\$8.00	13.0%	9.15 Yrs	
\$8.50	12.0%	9.90 Yrs	
\$9.00	11.1%	10.69 Yrs	
\$9.50	10.3%	11.51 Yrs	
\$10.00	9.5%	12.36 Yrs	
\$10.50	8.8%	13.26 Yrs	
\$11.00	8.2%	14.20 Yrs	

### Critical Factor Analysis

Deviation Effect on Feasibility



## Exhibit C-10 (cont.) – Detailed Sensitivity Analysis and Critical Factor Analysis

### Critical Factor Analysis

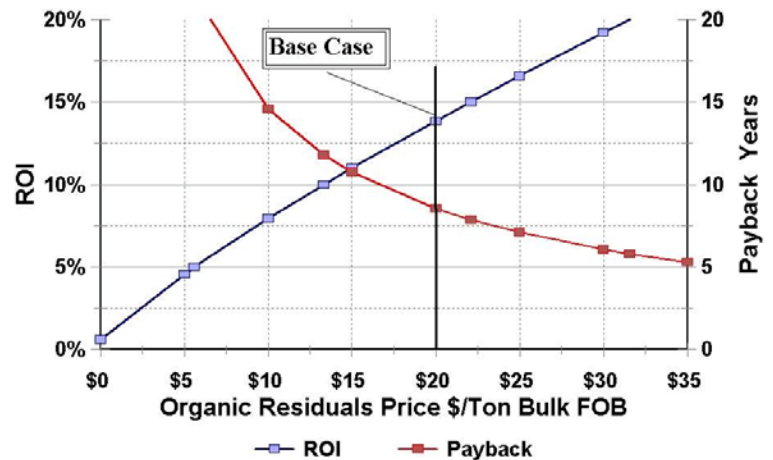
**Factor -- Organic Residuals Value -- \$/Ton**

**Description --** Average selling price for the organic residuals, bulk FOB the site.

Value	ROI	Payback	Notes
\$0.00	0.6%		
\$5.00	4.6%	23.17 Yrs	
\$5.59	5.0%	21.61 Yrs	
\$10.00	7.9%	14.59 Yrs	
\$13.32	10.0%	11.80 Yrs	
\$15.00	11.0%	10.77 Yrs	
\$20.00	13.8%	8.56 Yrs	Base
\$22.10	15.0%	7.88 Yrs	
\$25.00	16.6%	7.11 Yrs	
\$30.00	19.2%	6.09 Yrs	
\$31.58	20.0%	5.82 Yrs	
\$35.00	21.8%	5.32 Yrs	

### Critical Factor Analysis

Deviation Effect on Feasibility



### Critical Factor Analysis

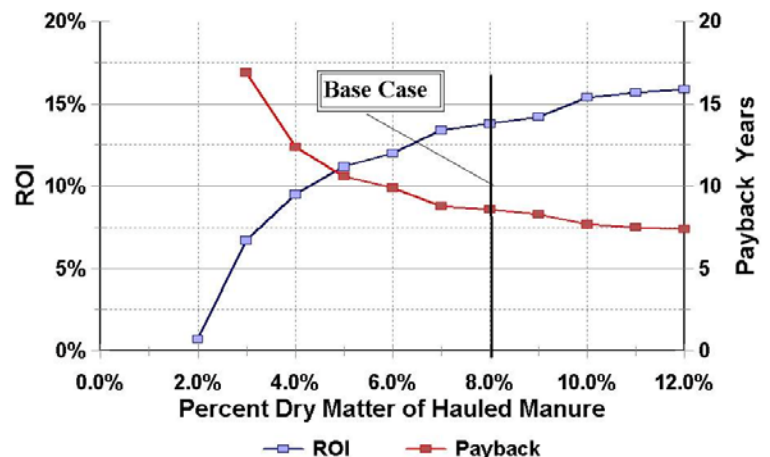
**Factor -- Percent Dry Matter of Hauled Manure**

**Description --** Dry matter content of the material hauled to and entering the digester, inverse of moisture content.

Value	ROI	Payback	Notes
1%		Yrs	
2%	0.7%	Yrs	
3%	6.7%	16.90 Yrs	
4%	9.5%	12.40 Yrs	
5%	11.2%	10.60 Yrs	
6%	12.0%	9.90 Yrs	
7%	13.4%	8.80 Yrs	
8%	13.8%	8.60 Yrs	Base
9%	14.2%	8.30 Yrs	
10%	15.4%	7.70 Yrs	
11%	15.7%	7.50 Yrs	
12%	15.9%	7.40 Yrs	

### Critical Factor Analysis

Deviation Effect on Feasibility





## Exhibit C-10 (cont.) – Detailed Sensitivity Analysis and Critical Factor Analysis

### Critical Factor Analysis

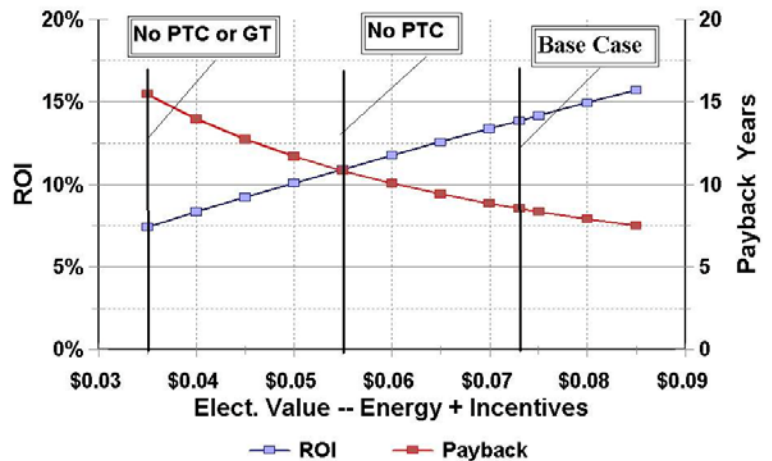
**Factor -- Electricity Value -- Energy + Incentives**

**Description --** Base electric sale price plus incentives which are tied to electricity production (PTC and Green Tags).

Value	ROI	Payback	Notes
\$0.035	7.4%	15.47 Yrs	
\$0.040	8.3%	13.96 Yrs	
\$0.045	9.2%	12.73 Yrs	
\$0.050	10.1%	11.70 Yrs	
\$0.055	10.9%	10.83 Yrs	
\$0.060	11.8%	10.08 Yrs	
\$0.065	12.6%	9.43 Yrs	
\$0.070	13.4%	8.87 Yrs	
\$0.073	13.8%	8.56 Yrs	Base
\$0.075	14.2%	8.36 Yrs	
\$0.080	14.9%	7.92 Yrs	
\$0.085	15.7%	7.51 Yrs	

### Critical Factor Analysis

Deviation Effect on Feasibility



### Critical Factor Analysis

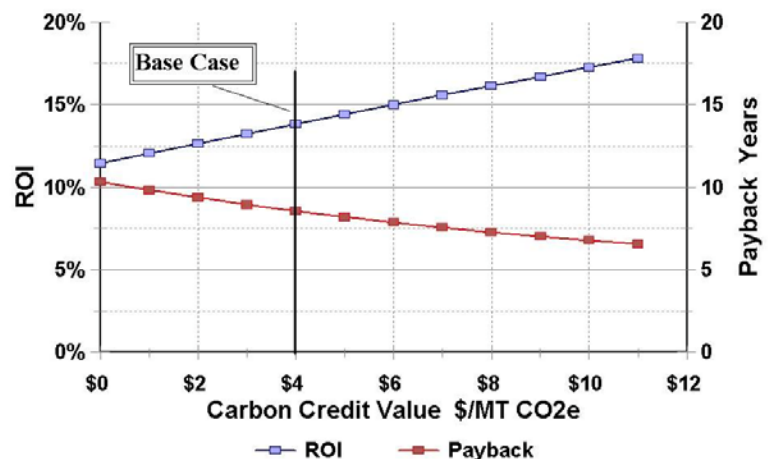
**Factor -- Carbon Credit Value \$/MT CO2e**

**Description --** Value placed on GHG reductions, per metric ton carbon dioxide equivalency.

Value	ROI	Payback	Notes
\$0.00	11.5%	10.35 yrs	
\$1.00	12.1%	9.83 yrs	
\$2.00	12.7%	9.37 yrs	
\$3.00	13.3%	8.94 yrs	
\$4.00	13.8%	8.56 yrs	Base
\$5.00	14.4%	8.20 yrs	
\$6.00	15.0%	7.88 yrs	
\$7.00	15.6%	7.58 yrs	
\$8.00	16.1%	7.30 yrs	
\$9.00	16.7%	7.05 yrs	
\$10.00	17.3%	6.81 yrs	
\$11.00	17.8%	6.58 yrs	

### Critical Factor Analysis

Deviation Effect on Feasibility



## Exhibit C-10 (cont.) – Detailed Sensitivity Analysis and Critical Factor Analysis

### Critical Factor Analysis

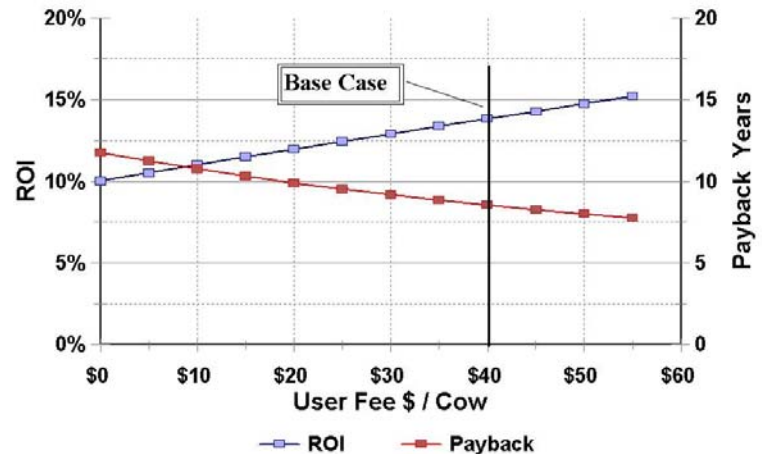
#### Factor -- User Fee \$ / Cow

**Description --** Fee paid by the dairymen for the services provided, covers cost of transport and liquid handling.

Value	ROI	Payback	Notes
\$0.00	10.0%	11.77 Yrs	
\$5.00	10.5%	11.24 Yrs	
\$10.00	11.0%	10.76 Yrs	
\$15.00	11.5%	10.31 Yrs	
\$20.00	12.0%	9.91 Yrs	
\$25.00	12.4%	9.53 Yrs	
\$30.00	12.9%	9.18 Yrs	
\$35.00	13.4%	8.86 Yrs	
\$40.00	13.8%	8.56 Yrs	Base
\$45.00	14.3%	8.28 Yrs	
\$50.00	14.8%	8.01 Yrs	
\$55.00	15.2%	7.77 Yrs	

### Critical Factor Analysis

Deviation Effect on Feasibility



### Critical Factor Analysis

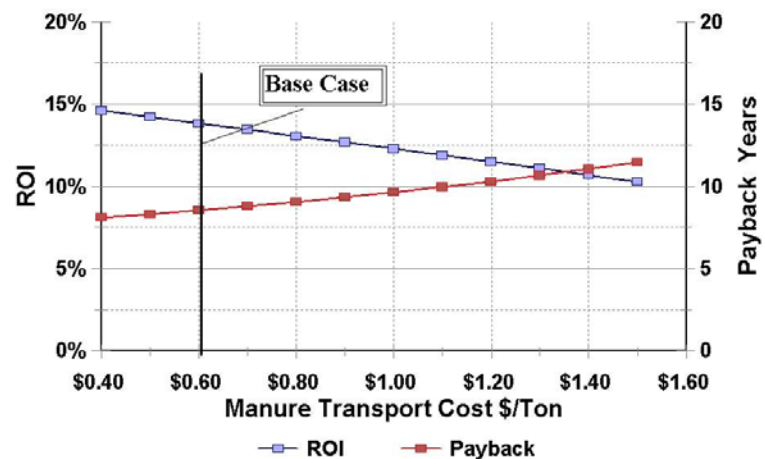
#### Factor -- Inbound Manure Transport Cost \$/Ton

**Description --** Cost per ton for operating the mechanism for delivering waste to the central site.

Value	ROI	Payback	Notes
\$0.40	14.6%	8.10 Yrs	
\$0.50	14.2%	8.32 Yrs	
\$0.60	13.8%	8.56 Yrs	Base
\$0.70	13.5%	8.81 Yrs	
\$0.80	13.1%	9.07 Yrs	
\$0.90	12.7%	9.35 Yrs	
\$1.00	12.3%	9.65 Yrs	
\$1.10	11.9%	9.96 Yrs	
\$1.20	11.5%	10.30 Yrs	
\$1.30	11.1%	10.67 Yrs	
\$1.40	10.7%	11.06 Yrs	
\$1.50	10.3%	11.48 Yrs	

### Critical Factor Analysis

Deviation Effect on Feasibility



## Exhibit C-10 (cont.) – Detailed Sensitivity Analysis and Critical Factor Analysis

### Critical Factor Analysis

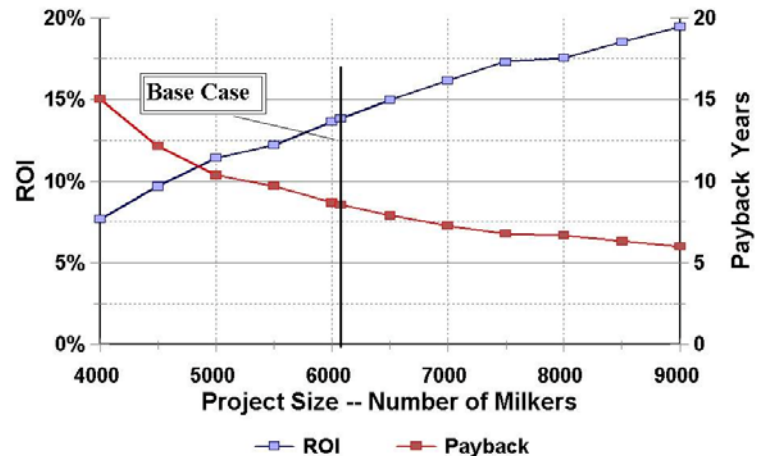
**Factor -- Project Size -- Number of Milkers**

**Description --** Number of milking cows whose manure enters the digester.

Value	ROI	Payback	Notes
4,000	7.7%	15.02 Yrs	
4,500	9.7%	12.17 Yrs	
5,000	11.4%	10.36 Yrs	
5,500	12.2%	9.70 Yrs	
6,000	13.6%	8.69 Yrs	
6,075	13.8%	8.56 Yrs	Base
6,500	15.0%	7.91 Yrs	
7,000	16.2%	7.29 Yrs	
7,500	17.3%	6.79 Yrs	
8,000	17.5%	6.70 Yrs	
8,500	18.5%	6.32 Yrs	
9,000	19.4%	6.00 Yrs	

### Critical Factor Analysis

Deviation Effect on Feasibility



### Critical Factor Analysis

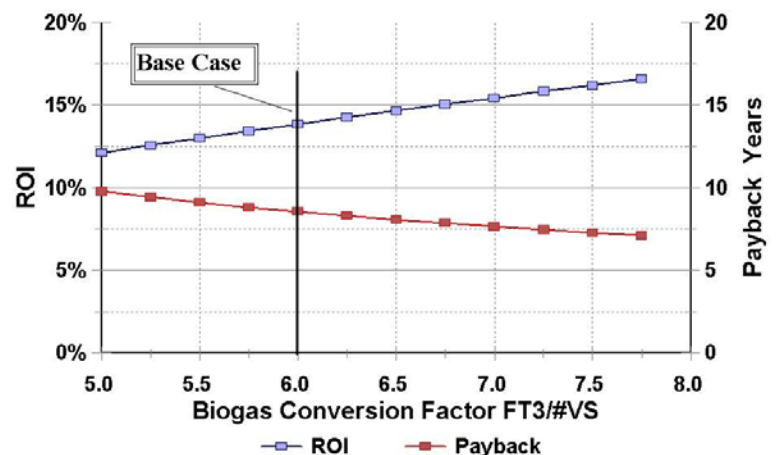
**Factor -- Biogas Conversion Factor FT3/#VS**

**Description --** Cubic feet of biogas produced for each pound of volatile solids entering the digester.

Value	ROI	Payback	Notes
5.00	12.1%	9.78 Yrs	
5.25	12.6%	9.43 Yrs	
5.50	13.0%	9.12 Yrs	
5.75	13.4%	8.83 Yrs	
6.00	13.8%	8.56 Yrs	Base
6.25	14.3%	8.31 Yrs	
6.50	14.7%	8.07 Yrs	
6.75	15.1%	7.85 Yrs	
7.00	15.4%	7.65 Yrs	
7.25	15.8%	7.46 Yrs	
7.50	16.2%	7.28 Yrs	
7.75	16.6%	7.11 Yrs	

### Critical Factor Analysis

Deviation Effect on Feasibility





## **Exhibit C-11– Worksheet for Evaluation of Financing Alternatives**

